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TESTING CONDITIONS FOR ENERGY STAR MEASUREMENT PRINTERS AND FAX MACHINES

Revised June 1995

In order to eliminate confusion and ensure consistency, the following protocol should be followed when measuring power for printers and fax machines under the ENERGY STAR Office Equipment Program.

Outlined below are the ambient test conditions which should be established when performing the power measurement. These are necessary in order to ensure that outside factors do not affect the test results, and that test results can be reproduced later. A description of the specifications for testing equipment, as well as a discussion of testing issues, follow on the succeeding pages.

I. TEST CONDITIONS

| | |
|---|------------------------|
| Line Impedance: | < 0.25 ohm |
| Total Harmonic Distortion: (Voltage) | < 5% |
| Input AC Voltage: ¹ | 115 VAC RMS +/- 5V RMS |
| Input AC Frequency: ¹ | 60 Hz +/- 3 Hz |
| Ambient Temperature: | 25 deg. C +/- 3 deg. C |

II. TEST METHOD

Printer and fax machine manufacturers should measure and report the **average** power consumption of their printer and fax machine products when in the low-power mode. This should be done by evaluating the printer or fax machine over a time period sufficiently long to include typical variations or surges in power (e.g., any cycling of the fuser). The recommended approach is to utilize a watt-hour meter, and measure the energy consumption in the low-power mode of the printer or fax machine over 1 hour. This will allow manufacturers to capture any variations in power usage that occur during the low-power mode. Dividing the measured energy consumption by the time period over which it is measured will produce average Watts. While this approach will

¹ If products will be sold in Europe or Asia, testing should also be performed at the appropriate machine-rated voltage and frequency. For example, products destined for European markets might be tested at 230 V and 50 Hz. The logo should not be displayed on products shipped to Europe or Asia if the equipment does not meet the power requirements of the Program at the local voltage and current conditions.

provide the most accurate results, it is not essential to follow this for printers and fax machines whose idle-mode power consumption does not vary (e.g., dot matrix printers, inkjet type printers and fax machines, and laser printers and fax machines where the fuser is turned off during idle mode). For printers and fax machines with constant idle-mode power consumption, manufacturers may choose to utilize a high quality watt-meter and take several measurements of instantaneous power.

III. TESTING EQUIPMENT

The goal is to accurately measure the TRUE power consumption² of the printer or fax machine. This necessitates the use of a **True RMS** Watt-Meter or Watt-Hour Meter. There are many watt-meters and watt-hour meters to choose from, but manufacturers will need to exercise care in selecting an appropriate model. The following factors should be considered when purchasing a meter and setting up the actual test.

Crest Factor

A previous version of EPA's testing procedure included a requirement that manufacturers utilize a meter with a crest factor greater than eight. As many Partners pointed out, this is not a useful or relevant requirement. The following paragraphs are meant to discuss the issues relating to crest factor and to clarify the intent of the initial statement. Unfortunately, EPA cannot provide a specific equipment requirement because testing is as much art as it is science. Manufacturers and testers will have to exercise judgement, and draw on people well versed in testing issues, to select an appropriate meter.

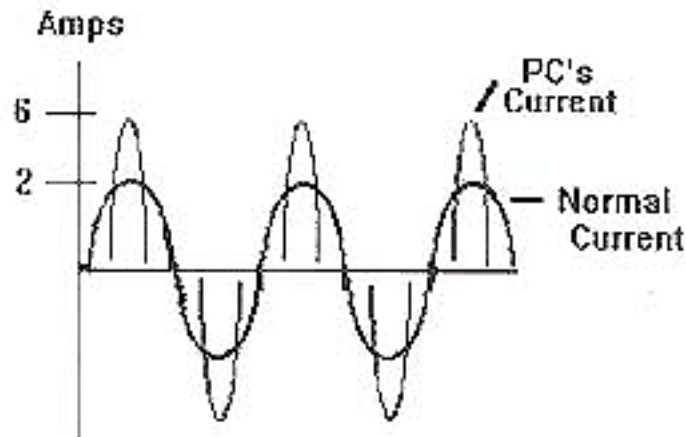
It is important to understand that electronic equipment such as printers and fax machines typically draw current in a waveform different from typical sinusoidal current.³ Figure 1 shows the typical current waveform for an electronic product containing a switching power supply.

While virtually any meter can measure a standard current waveform, it is more difficult to select a meter when irregular current waveforms are involved.

² True power is defined as (volts)x(amps)x(power factor), and is typically reported as Watts. Apparent Power is defined as (volts)x(amps) and is usually expressed in terms of VA or volt-amps. The power factor for equipment with switching power supplies is always less than 1.0, so true power is always less than apparent power.

³ The crest factor for a sinusoidal 60 Hz current waveform is always 1.4. The crest factor for a current waveform associated with equipment containing a switching power supply will always be greater than 1.4 (though typically no higher than 8). The crest factor of a current waveform is defined as the ratio of the peak current (amps) to the RMS current (amps).

Figure 1



It is critical that the meter selected be capable of reading the current drawn by the printer or fax machine without causing internal peak distortion (i.e., clipping off the top of the current wave). This requires a review of the meter's crest factor,⁴ and of the current ranges available on the meter. Better meters will have higher crest factors, and more choices of current ranges. When preparing the test, the first step should be to determine the peak current (amps) associated with the printer or fax machine being measured. This can be accomplished using an oscilloscope. A current range must be selected that will enable the meter to register the peak current. Specifically, the full scale value of the current range selected multiplied by the crest factor of the meter (for current) must be greater than the peak current reading from the oscilloscope. For example, if a meter has a crest factor of 4, and the current range is set on 3 amps, the meter can register current spikes of up to 12 amps. If measured peak current is only 6 amps, the meter would be satisfactory. However, if the current range is set too high in order to register peak current, then it may lose accuracy in measuring the non-peak current. Therefore, some delicate balancing is necessary. Again, with more current range choices and higher crest factors you will get better results.

Frequency Response

Another issue to consider when selecting a watt-meter is the frequency response rating of the meter. Electronic equipment that contains switching power supplies causes harmonics (odd harmonics typically up to the 21st). These harmonics must be accounted for in power measurement, or the Wattage consumption will be inaccurate. Accordingly, EPA recommends that manufacturers purchase meters that have a frequency response of at least 3 kHz. This will account for harmonics up to the 50th, and is recommended by IEC 555.

Resolution

When testing printers and fax machines whose power consumption is close to the ENERGY STAR requirements, manufacturers will probably want a meter than can provide resolution of 0.1 W.

Accuracy

⁴ The crest factor of a watt meter is often provided for both current and voltage. For current it is the ratio of the peak current to the RMS current in a specific current range. When only one crest factor is given, it is usually for current. An average True RMS Wattmeter has a crest factor in the range of 2:1 to 6:1.

Another feature to consider is the resulting accuracy you will be able to achieve. Catalogues and specification sheets for watt-meters typically provide information on the accuracy of power readings that can be achieved at different range settings. If you are measuring a product that is very close to the 30 or 45 watt ceiling, you will need to set up a test that will provide greater accuracy. For example, if the resulting accuracy for your watt-meter at the test settings is ± 0.5 W, then with a measured power consumption of ≤ 29.5 W you can be fairly sure that your printer or fax machine is compliant.

Calibration

Meters should be calibrated every year to maintain their accuracy.

QUESTIONS AND ANSWERS REGARDING TESTING PROCEDURES FOR ENERGY STAR PRINTERS AND FAX MACHINES

Q: Are these printer and fax machine testing guidelines mandatory?

A: EPA's testing guidelines are not mandatory, but we will distribute them to outside parties such as buyers and the computer press. Following these guidelines and producing accurate test results will help companies avoid problems with the compliance of their products. You may determine the appropriate level of stringency and accuracy for your own testing based on your specific product. For example, if your printer or fax machine does not contain a switching power supply, then you will not need to be as careful choosing a meter. Also, if you know your printer or fax machine has relatively stable power consumption in idle mode (i.e., the fuser never comes on), then you probably don't need to measure for a full hour. If your fuser cycles occasionally, your power consumption varies, or you are very close to the maximum allowed wattage, you should probably measure for a full hour to get the most accurate results. (The ASTM guidelines for testing include requirements that all measurements be made over a 1-hour time period.)

Q: Where can I find a True RMS watt-meter or watt-hour meter that will meet my requirements?

A: A true RMS watt meter can be ordered from several manufacturers. The EEM catalogue lists about 75 companies under Meters, Watt. Probably only a third of these companies make meters suitable for ENERGY STAR measurement. Some manufacturers that carry watt-meters that may be appropriate include: AMEC, Clarke-Hess, NGI-Norma, Ohio Semitronic, Valhalla, Voltech, and Yokogawa. When you call any of these manufacturers be sure to tell them what you need the equipment for, and request their specification sheets. (As companies find adequate meters, please let me know so I can share them with other Partners.)

Q: Can I assume the voltage coming out of my wall socket is close to 115 V?

A: No. The voltage coming out the wall could easily vary by more than +/- 5 V from the suggested 115 Volts AC. By applying a "resonant" line voltage regulator between the wall outlet and the device under test, the input voltage can be regulated to 115 V +/-1%.

Q: Will the voltage coming out of the wall have a harmonic distortion <5%?

A: Not always. However, a "resonant" line voltage regulator will help to regulate distortion to within 3%.